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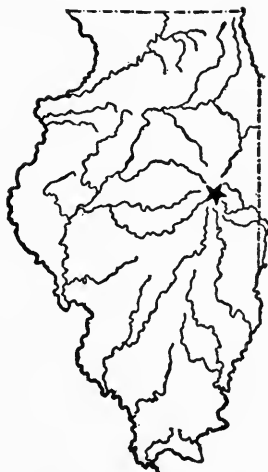
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BULLETIN No. 289

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EXPERIMENTS IN THE SELF-FEEDING  
OF DAIRY COWS

By W. B. NEVENS



URBANA, ILLINOIS, MAY, 1927

## SUMMARY

Eight dairy cows were fed by the self-feeder or free-choice method of feeding for periods ranging from 14 to 130 weeks.

There was a general tendency for the cows to consume nutrients greatly in excess of their requirements as estimated from the Armsby feeding standard. For a short period following calving, however, several cows failed to consume sufficient nutrients to meet their estimated needs. With the exception of one case, protein was consumed in greater excess than net energy.

The high level of feed intake resulted in a marked increase in weight of most of the cows and presumably, therefore, a higher maintenance cost. It seemed at first that some of the cows would gradually accustom themselves to a consumption of nutrients upon a level with their requirements, but such an adjustment failed to appear in the period covered by the experiments. For the reasons given, therefore, self-feeding proved uneconomical.

The self-feeder method proved useful in studying the relative palatability of different feeds. Not all cows showed preferences for the same feeds, however. Some were consumed freely to the almost entire exclusion of others to which the cow had access. The preferences of several of the cows changed suddenly and the marked partiality for a certain feed often extended over a long period. Mixed concentrates proved less palatable than the same concentrates fed separately, as judged by the total concentrate consumption, altho there were exceptions to this. No two cows exhibited the same preferences for all feeds.

Corn proved the most palatable of the low-protein concentrates used. Even tho concentrates were consumed in very large amounts, the amount of roughage eaten remained at a high level.

The few records of milk production secured failed to indicate that milk secretion was stimulated by the self-feeder method as compared with the usual method of hand-feeding. Limiting cows to high-protein feeds only, seemed to have a depressing effect upon milk production.

No harmful effects from self-feeding upon the health or reproductive functions of the cows were shown within the period of the experiment, but there is some possibility that injurious effects upon the body tissues were being gradually brought about in cows limited to high-protein feeds only. It may be that some physiological disturbances were responsible for the lessened milk production which accompanied the high-protein feeding.



# EXPERIMENTS IN THE SELF-FEEDING OF DAIRY COWS<sup>1</sup>

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The self-feeder or free-choice method of feeding both roughages and concentrates has been employed successfully with a number of different species of animals, such as swine, sheep, cattle, and poultry, under both experimental and practical farm conditions. This plan of feeding has been especially favored in the fattening of animals for market, since it usually results in the consumption of much larger quantities of feed and thus more rapid and economical gains than hand-feeding. There is also, as a rule, a saving in labor.

Altho this method has been used for many years in the feeding of beef cattle, but little use of it has been made with dairy cattle, except to a limited extent in raising calves and in the feeding of roughages.<sup>2</sup>

The idea that greater milk production might be secured from dairy cows by the free-choice method of feeding than by the usual plan of hand-feeding was the chief motive for undertaking this investigation. It seemed reasonable to assume that if a cow were given access constantly to a supply of feeds known to be suited to milk production, she might eat more than when hand-fed and her milk yield be thereby increased. Several other questions connected with the self-feeding of dairy cows were also studied: namely, the economy of the method; whether cows given freedom in selecting their own feeds would consume the different ones in such amounts that the proper proportions would be maintained among the several nutrients; and whether self-feeding could be employed without injury. The relative palatability of the different feeds was also a point of interest in the study.

So far as the author has been able to ascertain, the first feeding trial with dairy cows in which the free-choice method was used exclusively was carried out at the Illinois Station under the direction of Professor W. W. Yapp in 1922 (Holler<sup>3</sup>). In view of the thoro man-

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<sup>1</sup>Submitted for publication April 15, 1926.

<sup>2</sup>Investigations in the feeding of dairy calves by the free-choice method have been reported by Hulce<sup>1</sup> at the Illinois Station, McCandlish<sup>2</sup> at Iowa, and Nevens<sup>3</sup> at Nebraska. Hunt<sup>4</sup> conducted a feeding trial in which a group of cows, after being fed in the usual manner in the stable each morning, was turned into a lot containing a self-feeder, where they remained until night.

ner in which that work was done, the results obtained are presented here in connection with those secured by the author.<sup>a</sup>

## HOW THE COWS WERE FED AND THE RECORDS SECURED

Eight cows of moderate productivity were used in the experiments. Until it could be demonstrated that the self-feeder method might be used without injury, it was not deemed advisable to place the highest-producing cows in the herd under an experiment of this kind.

Records of feed consumption, live weight, and milk production were secured by the author for four cows for periods of different lengths, one cow being under experiment 60 weeks, another 78 weeks, the third 104 weeks, and the fourth 130 weeks. Similar records were secured by Holler<sup>5</sup> for one cow for 26 weeks, one cow for 20 weeks, and two cows for 14 weeks each. The cows were kept in individual box stalls in each of which a self-feeder provided a continuous supply of several different feeds (Fig. 1). They had access to the feeds at all times except for periods during the day when they were turned outdoors for exercise and water. The length of the exercise periods varied from one to several hours, depending upon weather conditions.

The self-feeder for concentrates contained four or five hopper compartments in which separate feeds were placed as needed in order to keep a constant supply of each. Silage and hay were usually fed in larger, separate compartments, some of which were provided with slatted covers to prevent loss of feed. Water was provided in some stalls by means of automatic water bowls. In the experiments by Holler the bedding consisted of straw, but in the subsequent experiments shavings were the only material used for this purpose.

The cows were gradually accustomed to the experimental conditions during a preliminary period of two to three weeks. Roughage and a concentrate mixture were offered in gradually increasing amounts until the cows were consuming all they cared for. Each concentrate was then placed in a separate compartment.

Records of feed consumption were secured by weekly periods and in some of Holler's work each day. At the end of each experimental

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<sup>a</sup>The facilities of the Department of Dairy Husbandry were placed at the disposal of Mr. L. S. Holler, a student in the College of Agriculture, for this study. Most of the records of feed consumption and live weight for two of the cows were obtained by Mr. Holler in person, while the same data for the other two, together with records of milk production and butterfat tests for all four cows, were secured by herdsman and laboratory helpers in the same manner as in the feeding trials conducted by the author.

week the feed remaining in each compartment was weighed and the amount recorded. Usually the feed was returned to the compartment and, if necessary, more feed added. Occasionally the feeds remaining in the hoppers at the end of the week were discarded and fresh supplies substituted.

Common salt was supplied in a separate compartment, and in some cases records of salt consumption were kept. Steamed bone meal or ground limestone was also supplied to four cows and some records

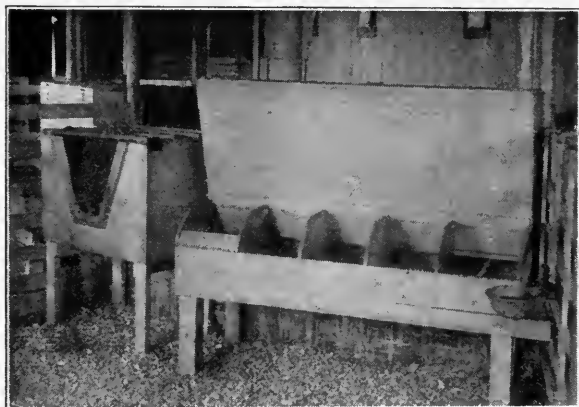


FIG. 1.—EQUIPMENT USED IN SELF-FEEDING DAIRY COWS

Each cow was kept constantly in a box stall where she had free access to a continuous supply of a number of feeds. No changes in the feed were made at calving time.

of their consumption secured. All cows were weighed weekly. No variation in the method of feeding or general routine was made on account of gestation or parturition.

The milk produced at each milking was weighed and sampled. Seven-day composite samples of the milk were preserved by means of mercuric chlorid tablets and were tested for butterfat by means of the Babcock test. A digestion trial was conducted with one cow while being self-fed and in a subsequent period while being hand-fed on a limited ration.

The feed records show that the amount of concentrates in certain compartments from which the cows apparently had not eaten often weighed from .1 to .2 of a pound and occasionally as much as .3 of a pound more at the end of the week than at the beginning. This may have been due to several causes. The feeds in being exposed to the

TABLE 1.—COMPARISON OF NUTRIENT CONSUMPTION AND REQUIREMENTS OF SELF-FED COWS  
(Arnsby Standard used as basis)

Cow	Duration of experiment	Digestible true protein			Net energy		Consumed above requirements
		Amount consumed	Amount required	Consumed above requirements	Amount consumed	Amount required	
	<i>weeks</i>	<i>lbs.</i>	<i>lbs.</i>	<i>perct.</i>	<i>therms</i>	<i>therms</i>	<i>perct.</i>
25.....	60	1 056	622	70	5 115	4 822	6
27.....	104	3 815	944	304	12 802	8 115	58
267.....	78	964	626	54	5 688	5 282	8
576.....	130	1 329	1 569	-15	17 107	11 713	46
274.....	26	339	224	51	2 639	1 915	38
290.....	15	303	176	72	2 150	1 374	57
649 <sup>1</sup> .....	14	271	207	31	1 459	1 433	2
650.....	14	242	152	59	1 784	1 184	51
Totals.....	...	7 120	3 657	...	39 672	29 069	...
290 <sup>2</sup> .....	5	61	62	-1	483	476	1

<sup>1</sup>Fed a concentrate mixture.

<sup>2</sup>Record for 12th to 16th weeks of trial, during which Cow 290 was hand-fed according to her requirements.

stable air for a week probably absorbed some moisture. The cows sometimes nosed over the feeds without eating them, thus possibly adding moisture to them. It was also observed that a cow while eating from one compartment moved her head about and sometimes dropped small amounts of feed into other compartments or on the floor. Hay and other feeds spilled on the floor were gathered up frequently and returned to the proper compartments. While an effort of

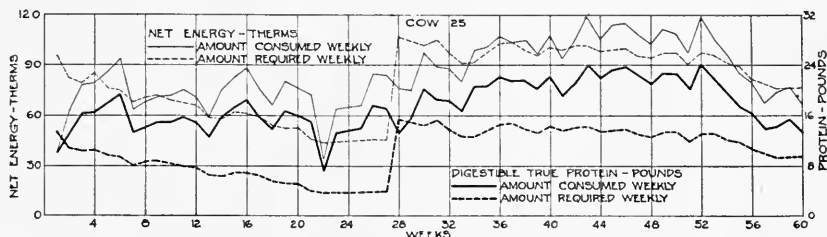


FIG. 2.—COW 25 WAS AN ECONOMICAL CONSUMER OF NET ENERGY BUT NOT OF DIGESTIBLE TRUE PROTEIN

This chart shows the large amount of digestible protein supplied by alfalfa hay, the only feed consumed. (See Fig. 10 for feed record.) Except during the week following calving, the alfalfa hay eaten furnished 70 percent more protein than was needed for body maintenance and liberal milk production. Greater milk production would doubtless have been secured had some concentrates been consumed, for at times the alfalfa hay eaten was not sufficient to meet the net energy needs. With alfalfa hay as the sole feed an excess of protein was of course supplied whenever enough hay was consumed to meet the net energy needs.

course was made to keep the records as accurate as possible, it was impossible to avoid the relatively small errors incurred in these ways.

The amounts of digestible true protein and net energy in the feeds consumed have been calculated in order to form a basis of comparison with the estimated requirements for maintenance and milk production.<sup>a</sup>

<sup>a</sup>The apparent live weights of cattle fluctuate greatly from day to day and from week to week, owing to variations in the water content of the body, rate of excretion of waste, feed intake, and various other causes. Variations in feed intake were very evident in this investigation. In order to secure a suitable basis for the calculation of data relative to live weight, the observed weights were smoothed according to a method given by Rietz.<sup>5</sup>

The digestible true protein and net energy contents of the feeds consumed, were calculated according to the average values published by Borland.<sup>7</sup> Analyses were made of some of the silage and hay fed, but these have not been used except in calculating the results of the digestion trial.

In order to provide a suitable basis for comparison with the amounts of nutrients consumed, the requirements of digestible true protein and net energy for

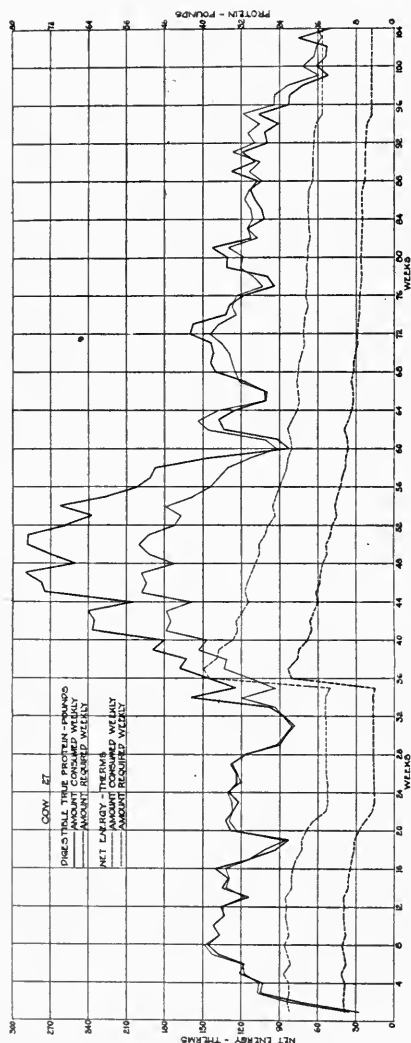


FIG. 3.—COW 27 WAS A WASTEFUL CONSUMER OF BOTH DIGESTIBLE TRUE PROTEIN AND NET ENERGY

This record illustrates strikingly the condition found to be generally true of self-feeding, namely, the lack of economy. Except for a few weeks following calving and at the beginning and close of the experiment, the intake of nutrients was greatly in excess of the requirements.

The extremely high intake of digestible true protein by this cow is very remarkable. It will be noted from Fig. 2 that during one week only was the consumption of this nutrient by Cow 25 above 24 pounds, yet Cow 27 consumed more than this amount most of the time and reached a maximum three times as great as that of Cow 25. The fact that all the feeds offered were rich in protein was partly responsible for the high intake of this nutrient, but it was not necessary for her to eat as much feed as she did simply to supply sufficient net energy.

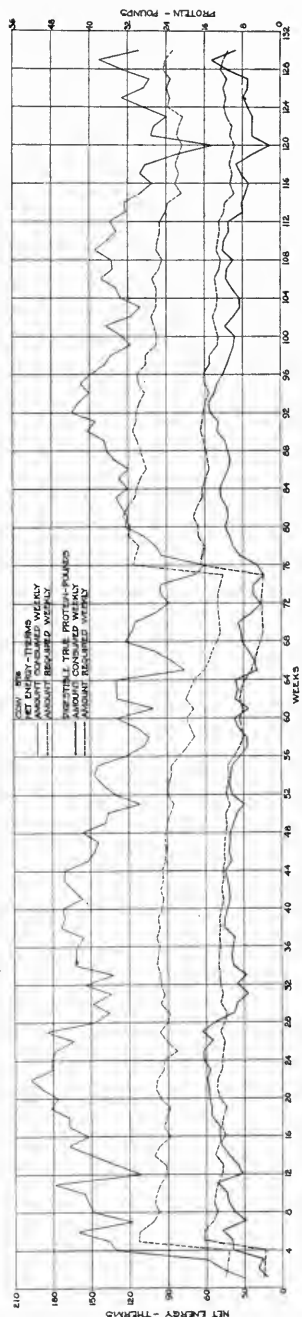


FIG. 4.—AN UNUSUALLY LOW INTAKE OF DIGESTIBLE TRUE PROTEIN CHARACTERIZED THE FEED RECORD OF COW 576

This cow continued to produce milk at quite a high level and to gain in weight (Fig. 12) altho her intake of digestible true protein over a period of six months was continuously lower than the estimated requirements. During the experiment as a whole, also, the total consumption of this nutrient was less than the estimated requirement. The net energy consumption was much above the requirement, which is characteristic of self-fed cows offered low-protein concentrates.

## SELF-FEEDER METHOD NOT SO ECONOMICAL AS HAND-FEEDING

That the self-feeder method for dairy cows is not economical from the standpoint of the amount of feed consumed may be seen by a glance at Table 1 and Figs. 2 to 9, in which the amounts of digestible true protein and net energy consumed are compared with the requirements of the animals for these substances as set forth in the Armsby feeding standard.

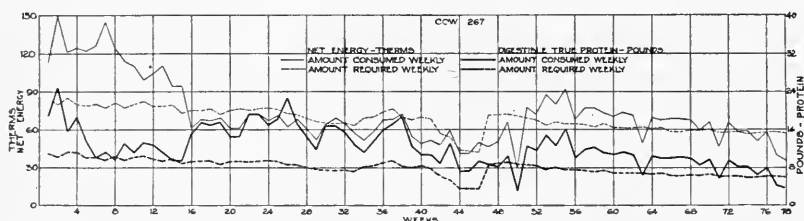


FIG. 5.—COW 267 RESEMBLED COW 25 IN BEING AN ECONOMICAL CONSUMER OF NET ENERGY BUT NOT OF DIGESTIBLE TRUE PROTEIN

During the first 15 weeks corn was offered, with the result that the intake of net energy was considerably above the requirements, but during the remainder of the experiment, when the concentrates consisted of high-protein feeds only, the consumption of net energy was variable but on the whole slightly below the required amount. The difference between the amounts of digestible true protein consumed and required was much less than for Cow 27.

Most of the cows at times consumed from 50 to 100 percent more net energy than their estimated requirements. The cows having access to some low-protein feeds, particularly corn, in general consumed a greater amount of net energy above their requirements than did the cows offered high-protein feeds or a concentrate mixture only.

The charts do not, however, tell the whole story with respect to the economy of the method. Most of the cows remained in a high

maintenance and milk production were calculated according to the Armsby standard as published by Borland.<sup>7</sup> It is recognized that feeding standards are merely guides to aid in securing approximately accurate results in practical feeding; while they may be far from exact under the widely varying conditions of practice and also of these experiments, it is believed that they afford a useful basis for studying the data secured in an investigation such as this.

Milk yields were corrected on the basis of their gross energy values to a uniform basis of milk containing 4 percent fat, according to the method of Gaines and Davidson.<sup>8</sup> This method assumes that one pound fat-corrected milk (F.C.M.) has an energy value of 331 large calories. Correction is accomplished thru the application of the formula,  $F.C.M. = .4 \text{ milk (in pounds)} + 15 \text{ fat (in pounds)}$ .



condition of flesh except for short periods at the beginning of the experiment and following calving. It has been shown,<sup>9,10</sup> that cattle fed on a high plane of nutrition fail to make as efficient use of their feed as when fed upon a low plane, and that these differences in extreme cases may be as much as 30 percent. Cow 576 weighed about 150 pounds more at the time of second calving during the self-feeder trial than at the previous calving which occurred early in the experiment. Cow 27

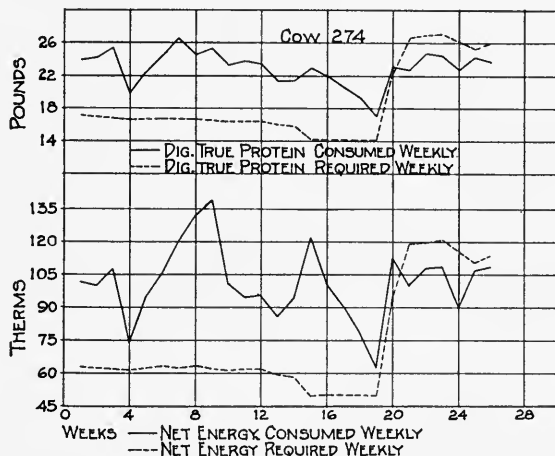


FIG. 6.—RATIONS OF SELF-FED COWS FAIL TO MEET REQUIREMENTS FOR A SHORT TIME AFTER CALVING

The record of the nutrient consumption of Cow 274 is typical of self-fed cows in showing an uneconomical consumption of feed except for a few weeks after calving, when the nutrient intake is too low.

at the time of calving, during the 34th week of the experiment, weighed about 175 pounds more than at her previous calving. These are increases of about 12.5 percent and 14 percent respectively in the weights of the cows, largely due to the method of feeding, altho they are to be partly accounted for by growth. If it be assumed that the efficiency of the feed was reduced when the cows were in a high state of flesh, then it would appear that the feed cost of maintenance when cows are self-fed over long periods is greatly in excess of that incurred by the usual method of hand-feeding.

From the standpoint of digestible true protein the amounts of feed consumed were quite uneconomical in most cases. The amount of net energy in the feed of Cows 25, 267, and 649 conformed more nearly to the requirements than in the case of the other cows, yet at times the feed contained 50 to 100 percent more digestible true protein than

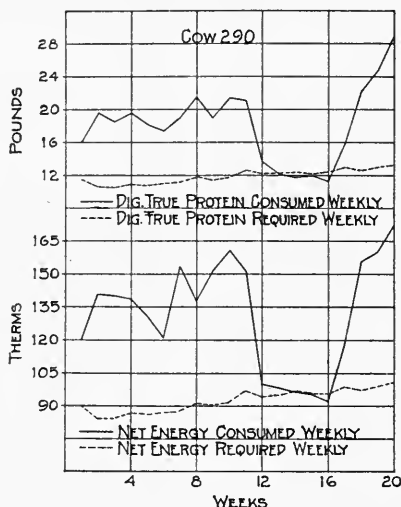


FIG. 7.—HAND-FEEDING PROVED MORE ECONOMICAL THAN SELF-FEEDING WITH THIS COW

From the 12th to 16th weeks, while Cow 290 was hand-fed, the intake of nutrients was practically equal to requirements. Previous and subsequent to this period, while this cow was self-fed, the consumption of nutrients was greatly in excess of requirements. (See Fig. 16 for records of weight and milk production).

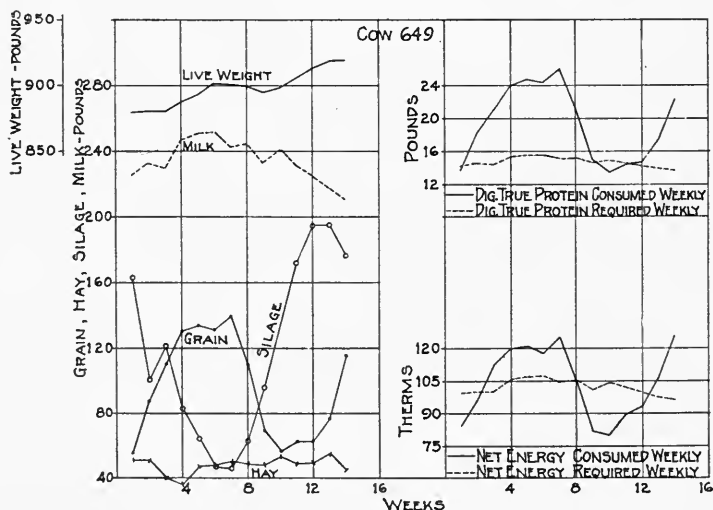


FIG. 8.—SUDDEN CHANGES OCCUR IN THE AMOUNTS OF NUTRIENTS THAT SELF-FED COWS CONSUME

Cow 649 was fed a grain mixture instead of being offered the various ingredients separately. For a time she consumed feed much in excess of her requirements, while for a few weeks her feed consumption was too low.

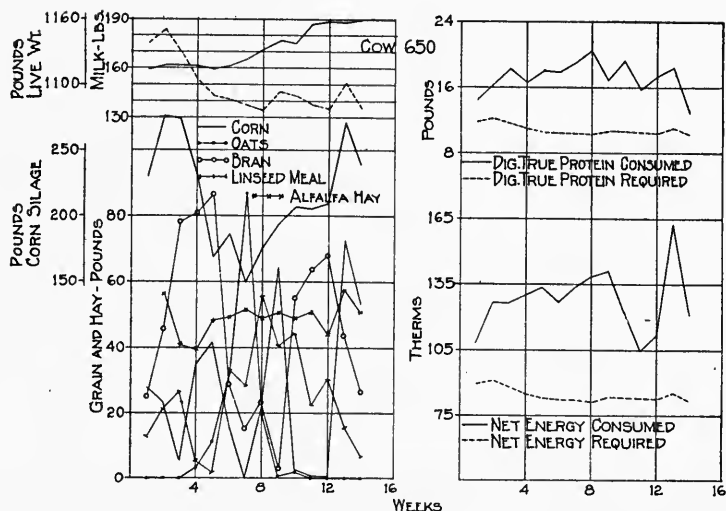


FIG. 9.—THE TOTAL NUTRIENT INTAKE OF COW 650 REMAINED CONSISTENTLY HIGH IN CONTRAST TO THAT OF COW 649, EVEN THO THE PREFERENCES OF BOTH COWS SHIFTED FREQUENTLY

The nutrients consumed by Cow 650 remained much above the estimated requirements, altho extreme changes occurred in the amounts of the different feeds eaten.

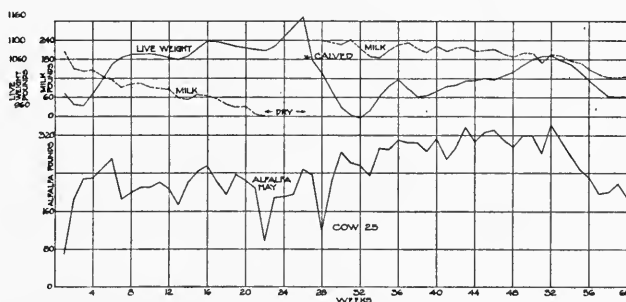


FIG. 10.—ALFALFA HAY PREFERRED TO PROTEIN CONCENTRATES BY COW 25

Alfalfa hay was the only feed consumed by this cow during the entire experimental period of 60 weeks, even tho she had access to a supply of linseed oil meal, cottonseed meal, and soybean oil meal. Note that following calving there was liberal milk production, together with an increase in live weight, with alfalfa as the sole feed.

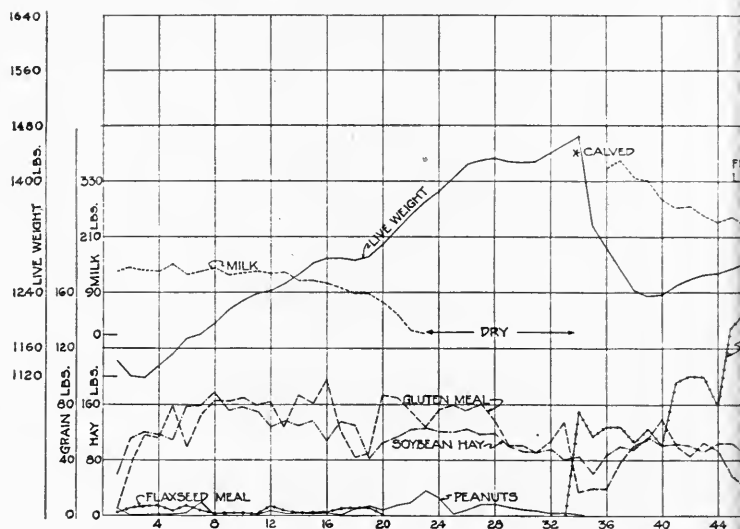


FIG. 11.—IN CONTRAST TO COW 25, COW 27 CONSUMED UNUSUALLY LARGE AMOUNTS OF PROTEIN CONCENTRATES. Variations in the preferences for different feeds are clearly evident from this record. On the whole there was a liberal consumption of feed, resulting in a marked increase in live weight. This cow ate not only large amounts

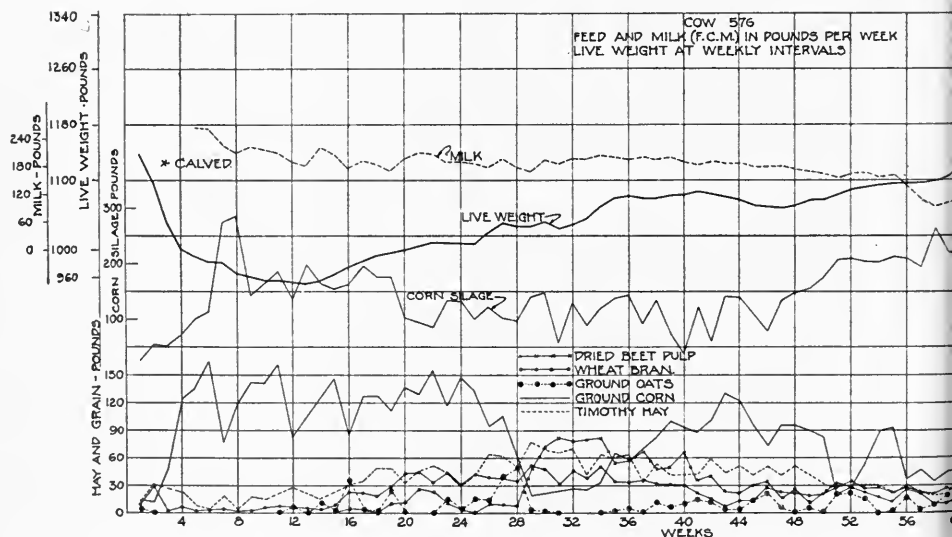
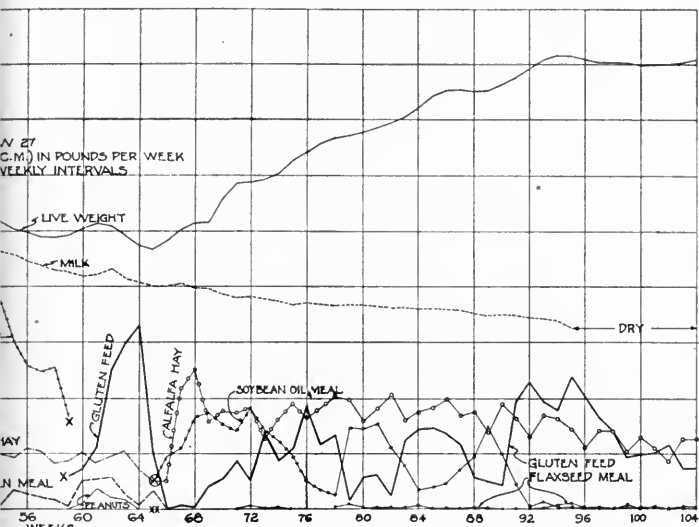
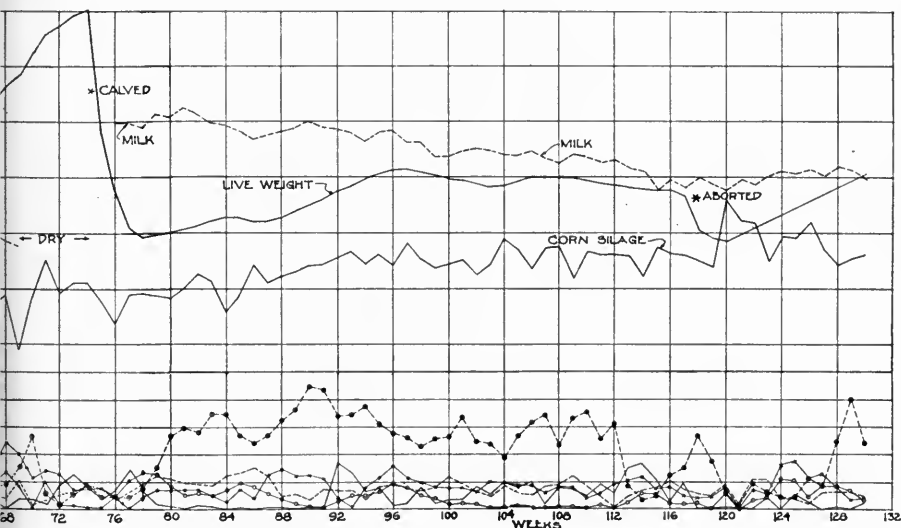


FIG. 12.—LOW-PROTEIN FEEDS PROVED SO PALATABLE TO COW 576 THAT BARELY ENOUGH WHEAT BRAN WAS CONSUMED TO MEET THE REQUIREMENTS FOR PROTEIN. One feed medium high in protein (wheat bran) was offered in connection with low-protein roughages and concentrates, so that the cow would have an opportunity to balance her ration with



of legume hay but also exceptionally large quantities of high-protein mill by-products. Peanut oil meal was offered from the beginning of the experiment, but none of it was consumed until the 33d week; the maximum quantity consumed weekly was greater than that of any other concentrate.



respect to protein. The animal showed a marked preference, however, for low-protein feeds, particularly corn and oats. Corn was especially favored during the first half of the experiment, but later oats took precedence over the other feeds.

needed. An excessive quantity was contained in the feed of Cow 27 during the 45th to 51st week. This amounted to 7 to 9 pounds daily above her estimated requirements, and during the 104 weeks the amount was 304 percent more than her calculated needs.

The data at hand are too limited to draw a sharp distinction between the high and low-protein regimes with respect to economy of protein consumption. The records secured so far indicate that the character of the feeds offered may have little influence upon the protein intake, provided the cow has access to feeds which will supply sufficient protein to meet her needs amply. Cow 576 seemed to be a marked exception, since she failed to consume enough protein to meet her needs as estimated by the standard.

### MOST SELF-FED COWS DO NOT SELECT PROPER AMOUNTS OF NUTRIENTS

The data are very conclusive in showing that the cows fed by the free-choice method did not select feeds in the proper amounts and proportions to meet their nutrient requirements. It was believed early in the experiment that after continued self-feeding the cows might gradually accustom themselves to the new conditions and consume only enough to meet their needs, but the extension of the experimental periods to 78 weeks or more failed to show that such habits were formed.

Altho feed consumption was upon a relatively high plane during the greater part of the lactation period, it fell below requirements at the time of parturition in the case of several of the cows (Figs. 2 to 6). This condition usually was reversed in four to six weeks. The cows used in these experiments were of only moderate dairy ability; it is possible that if cows of exceptional dairy ability were self-fed, they might consume feed about on a level with their requirements thruout considerable portions of their lactation periods. Plans have been made to secure data upon this point.

In but few cases did the consumption of net energy and digestible true protein closely approximate the calculated amounts needed (Table 1). Most cows not only consumed more feed than they needed, but their selection of the various nutrients was in most cases inconsistent. Usually the excess of net energy above the theoretical requirements was either much greater or much less than the excess of digestible true protein.

The discrepancy between the calculated protein requirements of Cow 576 and the amounts this animal actually consumed is of interest. From the 29th to the 58th week inclusive the requirement curve is

above the consumption curve, and yet the cow continued to increase in weight and to produce milk at quite a constant rate up to the 55th week. It is thus very improbable that she was drawing upon her body tissues for a supply of protein. Judged by this one case, the Armsby standard seems to prescribe a somewhat too liberal amount of protein, altho the apparent deficiency may be accounted for in part by the method of calculation used. Feeds vary in composition, particularly in dry-matter content, from season to season and during storage. This is true of corn, oats, and corn silage, which formed a large proportion of the feed of this cow.

### INDIVIDUAL PREFERENCES FOR FEEDS CHANGE SUDDENLY

It was interesting to note the decided preferences of cows for certain feeds and the way in which these preferences often changed suddenly. Figs. 8 to 12 and 14 to 16, which show the variations in feed intake from week to week, bring out the marked preferences for certain feeds. Figs. 17, 18, and 19 show the relative consumption of feeds upon a percentage basis. The records of each cow have been divided into consecutive periods of 13 weeks (three months) each. Altho the preferences of a cow often changed decidedly during three months, it is believed that a period of this duration is none too long to ascertain whether or not certain feeds would be consumed at all, for in the case of some cows a feed might not be touched during the first two or three weeks or longer and later be consumed freely. In these comparisons of the consumption of various feeds, the term palatability has been used to indicate the inclination of the cows to eat a certain feed, whether impelled to do so by the taste of the feed or by some body craving.

With the primary object of studying the relative palatability of various high-protein concentrates, Cow 267 was fed 20 pounds of corn silage daily as the only roughage, while the concentrates were fed *ad libitum*. In Fig. 17 the record for the first 15 weeks has been omitted because of several changes in the feeds offered. Linseed oil meal was the only concentrate consumed during all five periods. About 4 pounds of distillers' dried grains were consumed during Period 1 and less than 12 pounds of soybeans during Periods 1 and 2. These two feeds, therefore, were not offered during subsequent periods. Soybean oil meal (oil-exPELLER process) was consumed freely during Period 1. New process soybean oil meal was introduced during Period 2 and was consumed in larger amounts than the other form. The consumption of cottonseed meal did not exceed 15 pounds in any period.

TABLE 2.—BREED, AGE, AND CALVING RECORDS OF SELF-FED COWS

Cow	Breed	Age at beginning of test <i>yrs. mos. days</i>	Days in milk at beginning of test	Calving record during test		
				Week when calving occurred	Weight of calf	Remarks
25.....	Grade Holstein.....	3-1-3	157	27	<i>lbs.</i> 100	Normal
27.....	Grade Holstein.....	3-1-0	151	34	117	Normal
267.....	Purebred Guernsey.....	4-9-6	14	46	...	Calf carried full term but dead at birth
576.....	Grade Holstein.....	4-6-0 <sup>1</sup>	.....	3 75	85 84	Normal Living calf; fair condition; afterbirth retained
274.....	Purebred Ayrshire.....	4-1-4	374	118 19	...	Aborted Calf weak; died
290.....	Purebred Holstein.....	2-1-22	18	None	...	
649.....	Crossbred Guernsey-Holstein....	2-3-17	51	None	...	
650.....	Crossbred Guernsey-Holstein....	3-11-18	164	None	...	

<sup>1</sup>Approximate, exact age unknown.



A striking illustration of the changes in a cow's preference for a certain feed is afforded in the consumption of wheat bran. During Period 1 Cow 267 ate less bran than any other feed, so small an amount (1.2 pounds) that it was not offered during Period 2. It was again offered in Period 3, with the result that 520 pounds were eaten in 9 weeks. In Period 4 it made up 98 percent of the concentrates



FIG. 13.—MOST SELF-FED COWS INCREASE RAPIDLY  
IN WEIGHT

This illustration shows the high condition of flesh of Cow 27 after being self-fed for about five months. All of the cows used in the experiments gained rapidly in weight and with the exception of Cow 25, remained in a higher condition of flesh than when hand-fed. Cow 25 was quite thin for several weeks after calving.

eaten and in Period 5, 99 percent. During Period 4 its consumption was 677 times as great as that of linseed oil meal, while in Period 1 151 times as much linseed oil meal was eaten as wheat bran. These variations in the preferences of Cow 267 for certain feeds are fairly representative of all the cows used, altho in some cases the variations were not so marked.

Cow 27 was offered high-protein feeds for 104 weeks. Some changes in feeds during Period 6, however, make it desirable to use only the first five 13-week periods for a study of palatability. Soybean hay, gluten meal, peanuts with hulls removed, peanut oil meal, and flaxseed meal were the feeds offered.

The feed record of this cow is characterized by a liberal and steady consumption of soybean hay, by a relatively small or zero con-

sumption of peanuts and flaxseed meal, by a liberal but rapidly declining consumption of corn gluten meal, and by a sudden and strong liking for peanut oil meal. The consumption of peanut oil meal was practically negligible until the 34th week, when it suddenly mounted to about 10 pounds daily, remaining at a level of 8 or 9 pounds daily until Period 4, when it rose to a maximum of 23 pounds daily. The consumption of this concentrate was actually greatest during Period 4, but relatively greatest during Period 5 on account of a decline in the consumption of other feeds.

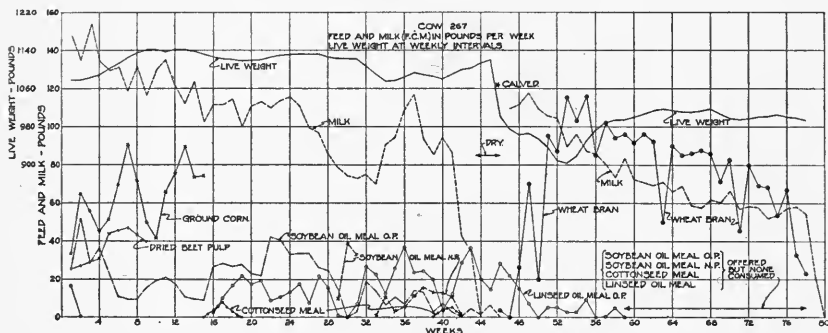


FIG. 14.—THE FEED PREFERENCES OF COW 267 CHANGED FREQUENTLY AND WERE VERY DECIDED

Wheat bran was offered for 21 weeks during the early part of the experiment, but practically none was consumed. It was offered again during the 46th week with the result that it soon was consumed very freely to the exclusion of all other concentrates offered.

Since Cow 25 ate alfalfa hay only and entirely ignored soybean oil meal (oil-exPELLER process), soybean oil meal (N.P.), cottonseed meal, and linseed oil meal (O.P.), it is impossible to draw conclusions regarding the relative palatability of these feeds except to state that in this case alfalfa hay was evidently far superior to the concentrates. This cow had been used in an earlier feeding trial in which soybean oil meal was compared with cottonseed meal. During the three-week period preliminary to offering the feeds in separate compartments, she was fed 70 pounds of alfalfa hay and 140 pounds of corn silage weekly. In addition she received a concentrate mixture consisting of ground corn, ground oats, and wheat bran (equal parts by weight). Of this she consumed 132.5 pounds the first week, 131 pounds the second week, and 126 pounds the third week. She was accustomed, therefore, to eating concentrates in quantity and had previously consumed readily most, if not all, of the kinds of feeds offered. The concentrates when offered separately did not seem so palatable as when mixed. It is

likely that this cow would have eaten certain other concentrates had they been offered. She calved during the first week of Period 3 and shortly afterward developed a severe attack of diarrhea. In order to remedy this condition, 53.5 pounds of scorched whole oats were fed. The oats were eaten readily and proved effective.

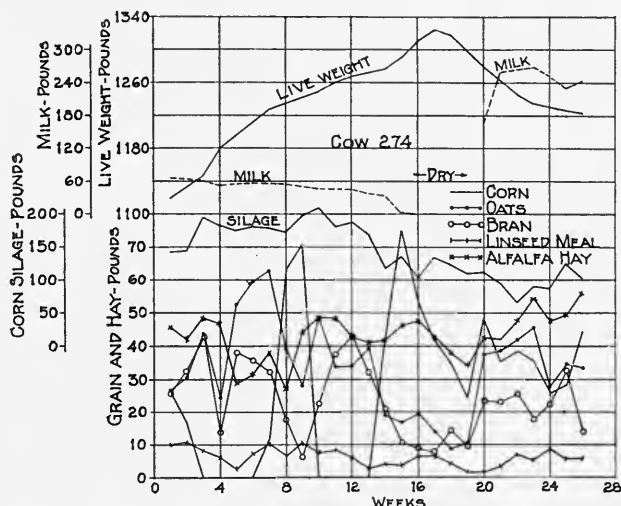


FIG. 15.—SUDDEN CHANGES IN FEED PREFERENCES WERE CHARACTERISTIC OF Cow 274

On two different occasions the amount of ground corn consumed dropped suddenly from quite a liberal amount, once over 70 pounds weekly, to zero. From the 10th to 13th weeks no corn at all was eaten, and then the consumption rose rapidly to about 75 pounds weekly. When the consumption of corn fell off, ground oats and wheat bran were eaten more freely.

The very remarkable preference of Cow 25 for alfalfa hay to the exclusion of the other feeds extended over a period of 60 weeks. This cow, weighing from 1,000 to 1,100 pounds, after giving birth to a 100-pound calf during the 27th week of the experiment, consumed as much as 341 pounds of hay weekly and yielded as much as 242 pounds of milk (F.C.M.) weekly.

It is clear from this investigation that variations in the preferences of cows for certain feeds may occur suddenly and extend over several weeks or months. Just how much bearing these results have on general practices in feeding for economical milk production, it is impossible to say, but it seems likely that in feeding cows during tests for maximum milk production a greater feed consumption could be induced by catering carefully to the cows' preferences.

## SELF-FEEDING APPARENTLY DOES NOT STIMULATE MILK PRODUCTION

The few milk production records secured in these tests do not offer great promise for the self-feeder method as a means of increasing production. It must be remembered, however, that records were obtained only with cows of moderate productivity.

All but three weeks of the third and fourth lactations of Cow 267 are shown in Fig. 14. If the milk production (F.C.M.) of the second

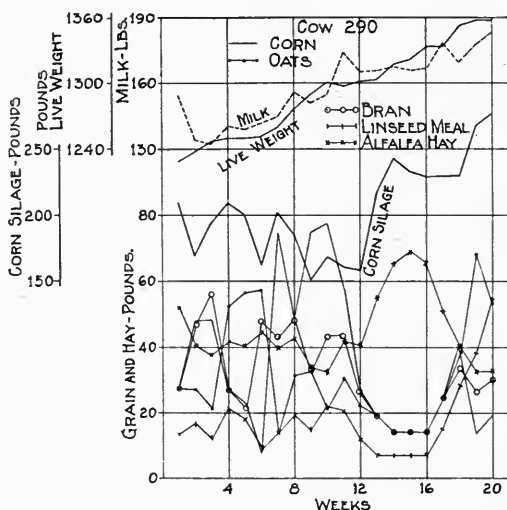


FIG. 16.—GROUND CORN PROVED MOST PALATABLE TO COW 290

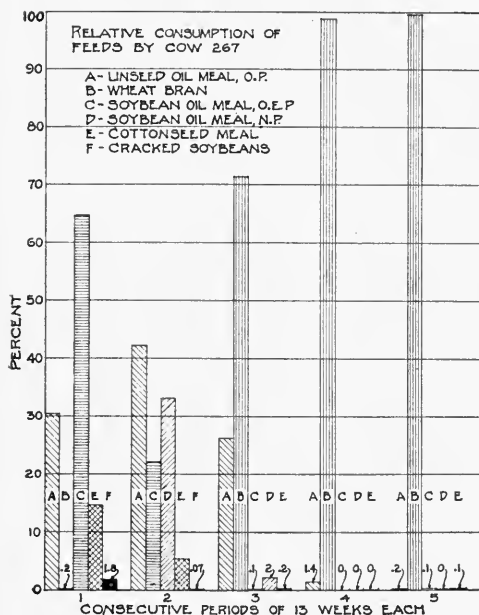
The feed record of Cow 290 was typical of cows self-fed on a variety of high- and low-protein feeds in that marked changes in the preferences occurred and that corn was consumed most freely of all the concentrates. This cow was hand-fed from the 12th to the 16th week inclusive. In spite of the marked reduction in the amount of concentrates fed, milk production was not lowered.

lactation, which was completed about seven weeks prior to the beginning of the self-feeder trial, be taken as 100, then the productions of the third and fourth lactations have the relations of 69 and 31 respectively. The decline in yield cannot be attributed to insufficient feed, since the amounts of feed consumed were large enough to support a greater milk yield (Fig. 5).

Cow 576 showed an increased yield under the self-feeding method, completing a lactation period of 448 days with a yield of 11,118 pounds

of milk (F.C.M.). The yield during the first 321 days of this period was 8,923 pounds. Her second lactation period of 321 days, completed about ten weeks before the beginning of self-feeding, had shown a yield of 7,580 pounds of milk. The maximum yield during any week of the third lactation was, however, only 5 percent greater and for the

FIG. 17.—SELF-FEEDING SHOWS THAT PREFERENCES FOR CERTAIN FEEDS MAY CHANGE FREQUENTLY



This chart shows the relative amounts of the concentrates consumed during consecutive periods of 13 weeks each. The total intake of concentrates during each period is considered as 100 percent, and the amount of each as a percentage of the whole. The roughage, which consisted of 20 pounds of corn silage daily, has not been considered, since it was hand-fed.

During Period 1 Cow 267 almost ignored wheat bran, consuming only 1.2 pounds, or less than 1 percent of the total concentrates, while during Periods 4 and 5 she ate practically no concentrates except wheat bran. Undoubtedly the freshness of the feed, its freedom from mold and musty odor, and the degree to which the feed possesses a pleasant aroma or taste, account to a large extent for the choice of feeds which a cow makes, but evidently they do not explain all

the results found. In this case, cracked soybeans did not prove palatable, but the soybean oil meal (oil-exPELLER process), which possessed a slightly roasted flavor and odor, was eaten freely. During Period 2 soybean oil meal, manufactured only a few days before delivery by a chemical solvent process, was offered and was consumed in larger amounts than any other concentrate. So far as known, the grade and quality of the wheat bran offered during Period 1 were the same as those of the wheat bran consumed during Periods 3, 4, and 5.

first 321 days only 18 percent greater than during the previous lactation. The self-feeding trial extended over the fourth lactation period also. The production of milk (F.C.M.) during this lactation, which was 304 days in length and was terminated by an abortion, was 9,454 pounds, or about 20 percent greater than that of the second lactation.

Cow 25 showed a decrease in yield under self-feeding, giving 288 pounds of milk (F.C.M.) during the week of highest production in her first lactation and 242 pounds while self-fed, or a ratio of 100 to 84. The maximum actual yield during one week of self-feeding when alfalfa hay was the sole feed consumed was 274.6 pounds containing 3.2 percent fat.

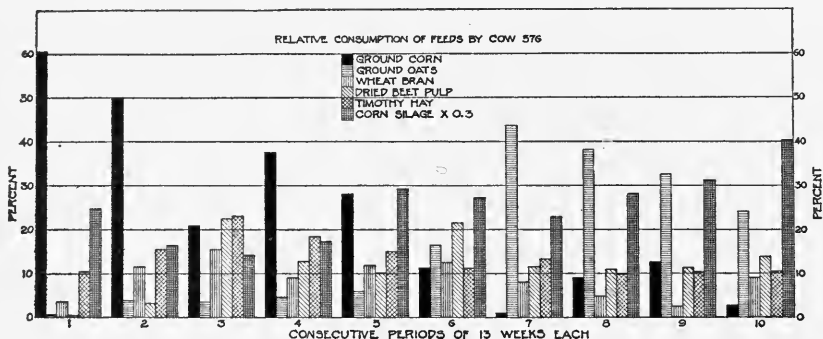


FIG. 18.—THE PREFERENCES OF SELF-FED COWS MAY REMAIN QUITE CONSTANT FOR MANY WEEKS AND THEN CHANGE DECIDEDLY

Both roughages and concentrates are included here. The amount of silage consumed was multiplied by the factor .3 in order to reduce it to a dry-matter basis which would be comparable to that of the other feeds.

During Period 1 corn formed about three-fifths of all the feed eaten, but during succeeding periods it became a much less important part of the ration. During Period 2 about 300 pounds more of corn were consumed than during Period 1, but on account of the increased consumption of other feeds during this period, corn formed a smaller proportion of the whole. The corn fed up to the middle of Period 10 graded No. 2 yellow. During Periods 7 to 9 it was more than one year old. It is not thought that the age of the corn was a factor, since it seemed to be in excellent condition. About the middle of Period 10 No. 3 yellow corn was fed. Even tho the silage appeared to be of poorer quality during Period 10, more was consumed than in any previous period.

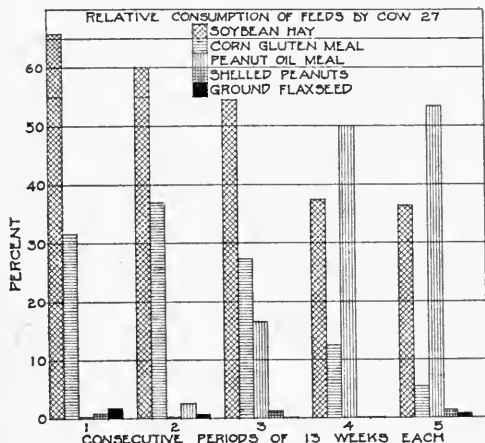
Aside from the two cases noted, no other changes were observed in the quality of the feeds which might have a bearing upon the amounts consumed.

The maximum weekly yield by Cow 27 during the lactation period which began in the 34th week of the self-feeding experiment, was 167 percent of the maximum during the preceding lactation period, which was her first, and during the first 18 weeks of which she was hand-fed. The decline in milk flow, however, was very rapid during both lactations (Fig. 11). The milk yield during the first lactation period of 43 weeks was 6,042 pounds (F.C.M.), while during the first 43 weeks of the second lactation it was 6,982 pounds (F.C.M.), or 116 percent of

the first. A part of the increased yield during the second lactation, as compared with the first, probably is to be accounted for by the natural increase in productivity which accompanies the development of young cows up to maturity.

In this investigation the free-choice method of feeding, which induced a consumption of nutrients greatly in excess of the requirements

FIG. 19.—THE RELATIVE AMOUNTS OF CERTAIN FEEDS CONSUMED IN DIFFERENT PERIODS BY COW 27 CHANGED GREATLY



The ration of Cow 27 was made up largely of soybean hay and two protein concentrates. During Period 1 soybean hay comprised about two-thirds of the total feed, declining to about one-third in Period 5. The concentrates consumed during Periods 1 and 2 consisted almost entirely of gluten meal, but beginning with Period 3 this was gradually replaced by peanut oil meal. So appetizing did the peanut oil meal prove that it formed over half the total feed and seven-eighths of the concentrates consumed in Period 5. In the peanut oil meal used, differences were noted in the quality of various

lots which might possibly account for the negligible consumption in Periods 1 and 2, followed by a sudden demand for it.

of the animals, failed to stimulate milk production to any higher point than the usual methods of feeding, and further, the limitation of cows to high-protein feeds seemed to have a distinctly depressing influence upon milk secretion.

### COWS CAN BE FED SAFELY BY THE SELF-FEEDER METHOD

So far as could be observed, no harmful effects upon the animals resulted from these self-feeding experiments. As indicated in the plan of procedure, no changes were made in the method of feeding on account of gestation or parturition. It is true that one calf was born dead and another died a short time after birth, while a third died at the age of about two weeks, but the last fatality is believed to have been due to the condition of the milk from the dam, which suffered a general toxemia as a result of a retained afterbirth. The calf had ap-

peared normal until a short time before its death. There is no evidence indicating that the other reproductive failures were or were not related to the experimental routine to which the dams were subjected. In the case of Cow 576, it is only known that abortion was prevalent in the herd of which she formed a part.

Cow 274 was "off feed" a number of times when she evidently had eaten too much corn, but this did not seem to affect greatly her milk production or general health.

A severe case of diarrhea was developed by Cow 25 shortly after calving, but this condition was readily corrected. This animal was removed from the experiment at the close of the 60th week on account of a positive reaction to the tuberculin test. A post-mortem examination revealed only a very small lesion.

In general, the health of the cows employed in this investigation seemed to be of the best. It is possible, however, that continuation of the experimental conditions over a longer period may reveal pronounced effects upon the health, particularly in connection with animals subsisting upon high-protein feeds. This phase of the study is being continued.

### SELF-FED AND NORMAL RATIONS DIFFICULT TO COMPARE IN DIGESTIBILITY

The consumption of large amounts of feed by self-fed cows naturally raises a question regarding the relative digestibility of such rations compared with normal rations. A digestion trial was carried out with Cow 274 in an effort to determine this point.

The trial consisted of two ten-day periods, during the first of which the cow was self-fed, while during the second she was fed closely in accordance with her estimated requirements. It was not considered feasible to provide all the feeds separately when the cow was confined in a metabolism stall in which the trial was conducted, so a concentrate mixture was made up in the proportion in which the feeds had been consumed previously. The mixture consisted of linseed oil meal, 7 percent; wheat bran, 25 percent; ground oats, 31 percent, and ground corn, 37 percent. Alfalfa hay and corn silage were offered separately. Each ten-day period was subdivided into five-day periods to furnish a means of checking the determinations. Altho the trial was carried out when the cow was in her third month of lactation and producing about 32 pounds of milk daily, she unfortunately did not consume as much of the concentrate mixture as she had previously eaten when the feeds were offered separately. This greatly reduced the value of the comparison.



The amounts of the feeds consumed during each five-day period, and the coefficients found for the rations made up in these proportions, are shown in Table 3. The differences in the coefficients for the self-feeder and the normal ration periods were practically negligible, probably owing to the fact that the difference in feed intake in the two periods (less than 2 kilograms of dry substance daily) was so small.

TABLE 3.—COMPARISON OF DIGESTIBILITY OF SELF-FED AND HAND-FED RATIONS

Amount of feed and orts for period	Coefficients of digestibility				
	Dry substance	Crude protein	Crude fiber	N-free extract	Ether extract
	Period 1a—Self-fed five days				
<i>grams</i> Silage.....24,050 Concentrates.....16,978 Hay.....31,326 Orts <sup>1</sup> .....7,131	68	70	48	75	67
	Period 1b—Self-fed five days				
Silage.....20,000 Concentrates.....18,169 Hay.....43,696 Orts <sup>1</sup> .....4,108	66	68	45	75	66
	Period 2a—Hand-fed five days				
Silage.....35,000 Concentrates.....20,000 Hay.....20,000 Orts.....0	68	70	44	77	78
	Period 2b—Hand-fed five days				
Silage.....35,000 Concentrates.....20,000 Hay.....20,000 Orts.....0	66	69	39	78	71

<sup>1</sup>Chiefly silage.

## CONCLUSIONS

The self-feeding of cows is not economical from the standpoint of the amounts of feed consumed, for much more feed than enough to meet their requirements for maintenance and milk production is eaten. Cows tend to lay on additional weight, thus increasing the maintenance cost.

The milk yields of cows of moderate productivity are not increased appreciably by self-feeding. Limiting cows to high-protein feeds only seems to depress milk production.

Cows which are self-fed usually consume feeds supplying an excess of net energy or digestible true protein or both. For a short period

following calving, however, the amounts of feed consumed may be too small to meet the requirements.

Feeding dairy cows by the self-feeder or free-choice method is not harmful to their health, provided they are gradually accustomed to the method.

The method is useful in studying the relative palatability of different feeds. Corn is the most palatable of the low-protein concentrates used.

The preferences of self-fed cows for particular feeds may change suddenly, and these preferences may continue over long periods. Cows differ widely in their individual preferences. It is likely that greater feed consumption can be secured when one studies these preferences carefully and caters to them. While this may be of some value under the usual conditions of good dairy practice, its greatest application is in feeding cows for records of maximum milk production.

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